

COURTSHIP AND MATING IN WILD *VARANUS VARIUS* (VARANIDAE: AUSTRALIA)

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Observations of wild *Varanus varius* in southern New South Wales indicate that mating takes place between mid-November and early January; that communication between individuals is by means of olfactory, visual and tactile cues; that females mate with several males, including subordinates; and that pairs mate frequently using hemipenes alternately. □ *Varanidae, mating, reproduction, behaviour, Varanus varius.*

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Goannas are wary lizards. Their behaviour in the wild is rarely documented although there are a number of published accounts of reproductive behaviour in captive varanids (Auffenberg, 1983; Moehn, 1984). The published records of mating in wild varanids include King and Green (1979), Tasoulis (1983), Wilson (1987) and Auffenberg (1978, 1981) but apart from Auffenberg's studies of *Varanus komodoensis* these provide little detail. This paper reports the results of observations on courtship and mating obtained as part of a wider study of reproduction in wild lace monitors.

MATERIALS AND METHODS

This work was undertaken in the valley of the Deua River, Deua National Park in southeastern New South Wales (35°46' S, 149°56' E). The country is steep and rugged with rocky soils covered by an open forest dominated by *Eucalyptus globoidea*. The study site is in the southern temperate part of the range of *Varanus varius*, which is the only varanid known to occur in the area (Cogger, 1986). Goannas were captured with a pole and noose, measured, weighed and marked and released at the place of capture usually within 24h. They were individually marked, temporarily with bands of acrylic paint around the tail and permanently by excising a combination of scales from the prominent fringe of scales under the rear fourth toes. The latter method was preferred to toe clipping because it did not deprive these arboreal lizards of one or more of their strongly clawed digits.

Males were sexed when seen mating, when

they fully everted their hemipenes during capture or handling, or by radiograph of the base of the tail showing the hemipenes which are partly ossified (Shea and Reddacliff, 1986). Animals were classified as females only when they were seen mating or by the absence of hemipene ossification in radiographs. Probing at the base of the tail was considered an unreliable method of sexing (Weavers, 1983; King and Green, 1979). A selection of animals were fitted with radiotransmitters (tracking only), which were attached with glue and stainless steel sutures to the side of the tail just behind the rear leg (method of Weavers, 1983). Complete transmitter packages weighed between 19 and 22g (<1.5 % body weight).

On the evening preceding a planned period of observation a telemetered animal was located in its roost. The next morning before 0730h I would take up a suitable position about 5-15m from the roost before the animal emerged. I was equipped with binoculars and radio receiver and was concealed under a frameless canvas hide which allowed me to move to keep animals in view (Carter, 1988). Although these lizards are usually very wary of humans and typically respond by climbing the nearest large tree, I was ignored by most animals whenever I wore the hide.

A total of 37 hours of observations from within the hide were made between 17 November, 1987 and 8 January, 1988. During the period from September, 1987 to March, 1988 a total of 81 days were spent at the study site and information on location and activity was recorded whenever individuals, pairs and groups of goannas were encountered. Events were timed to the nearest

minute, Eastern Standard Time. Because it was impracticable to use video or still cameras, diagrams of behaviour were drawn from photographs of dead goannas arranged in accordance with detailed field notes

RESULTS

Ten marked animals and another five unmarked were observed either mating or in what were presumed to be mating groups. Table 1 summarises data about the marked animals observed; Table 2 provides details of the groups seen.

MATING SEASON

Throughout most of the year lace monitors were found to be solitary (174 solitary individuals were recorded). However between 18 November and 2 January, I saw 11 groups of goannas; some of which were mating, some fighting, some roosting together, and some that were surprised on the ground and climbed into

Id No.	Sex (method)	SVL (cm)	Weight (kg)	Date (1st Capt.)
1	M(h)	65.0	6.30	10.09.87
3*	F(x)	49.0	2.10	18.09.87
7	U	43.5	1.16	06.10.87
11*	M(m)	78.0	7.00	21.10.87
14*	F(m)	46.5	2.06	22.10.87
18*	M(?)	58.5	3.75	18.11.87
19*	M(?)	73.0	7.25	18.11.87
22*	M(?)	61.5	4.65	18.11.87
26	M(h)	66.0	5.40	24.11.87
32*	F(m)	47.5	1.85	20.12.87

TABLE 1. Data concerning marked individuals found in mating/courting groups. Sex is followed in brackets by method of sexing, U = unknown sex, h = everted hemipenes, x = radioxerograph, m = mating, ? = probably male because of behaviour towards known males and females. Asterix indicates animals which were carrying a transmitter during observations.

TABLE 2. Dates, activities and composition of mating groups observed November 87 to January 88. F=female, M=male, n=not marked, U=unknown sex, a= unmarked but recognisable individual.

Date	No of goannas	Activity	Individuals
18.11.87	3	on ground	14(F), 18(M), 19(M)
20.11.87	2	roosting in mound	(F), 18(M)
21.11.87	2	mating	14(F), n(M)a
22.11.87	3	roosting in mound	14(F), 11(M), n(U)
23.11.87	2	fighting	n(M)a, 11(M)
23.11.87	6	fighting/mating	11(M), 14(F), 18(M), n(M), n(M), n(F)
24.11.87	3	on ground	7(U), n(U), n(U)
20.12.87	2	on ground	32(F), 22(M)
23.12.87	2	mating	32(F), n(M)
26.12.87	2	on ground	32(F), 26(M)
02.01.88	2	on ground	3(F), 1(M)

trees before I could see what they were doing. These observations indicate that the mating season extends from about mid-November to early January.

MATING SYSTEM

Females mated with several males over a period of days. Female 14 was seen to mate with two different males and over a period of 6 days associated with at least six different males. Female 32 was found on three separate days with three different males and was observed mating with one of them. Mating/courting groups varied from just the pair to as many as six individuals. If females were accompanied by more than one male the largest would chase other males that approached the females.

COMMUNICATION AND COURTSHIP

Lace monitors appear to use three forms of

communication - olfactory, visual and tactile. Scent trails and marking of particular sites are used to communicate over long distances or periods of time whereas body position and head movements are used to communicate directly when animals can see each other. Tactile cues become important as the male comes close to the female and attempts to straddle and mount her.

Male 11 was seen to follow, for about 20m, the exact pathway taken by another male 10min earlier. Male 11 moved slowly with wide sweeps of the head and rapid flicking of the tongue consistent with detecting and following a scent trail (Auffenberg, 1982). On another occasion an unmarked male approached a tree where male 18 had basked 80min previously. After flicking his tongue around the base of the tree for about 1min the unmarked male carefully wiped both sides of his head on the tree trunk and then repeated this action before moving away. Another unmarked male was observed for 1h as he located the overnight roost (hollow log) of female 32 and then followed her exact path to the nearby tree where she had moved to bask 2h 18min earlier. While he was locating her he stopped twice to vigorously rub his cloacal region against the ground and twice to rub his head, neck and throat on a tree and a log near her roost. During his approach to her roost, he moved very slowly over a distance of about 100m and appeared to be carefully scenting the ground with rapid flicks of

his tongue. He also seemed to be pressing his cloaca to the ground as he walked.

One large termite mound appeared to be an important focus of breeding activity for animals 11, 14, 18, 19 and at least 5 unmarked goannas. The mound had a large hole dug into the side. Over one week of observations several of these goannas roosted in the hole overnight and during the day there were frequent skirmishes between males that tried to approach the mound. Two males, which were seen mating or attempting to mate with females, had both visited the mound less than thirty minutes before they were seen with the females and may have picked up the female scent trail at the mound.

Goannas, which were close enough to see each other, adopted distinctive posture and head movements according to their sex (Fig. 1.). Females remained still or moved slowly, always with their bodies flat on the ground and necks extended along the ground. Females were inconspicuous. In contrast, the movements of males were rapid and exaggerated, making them conspicuous. Males held their bodies raised from the ground, the neck usually vertical and the head

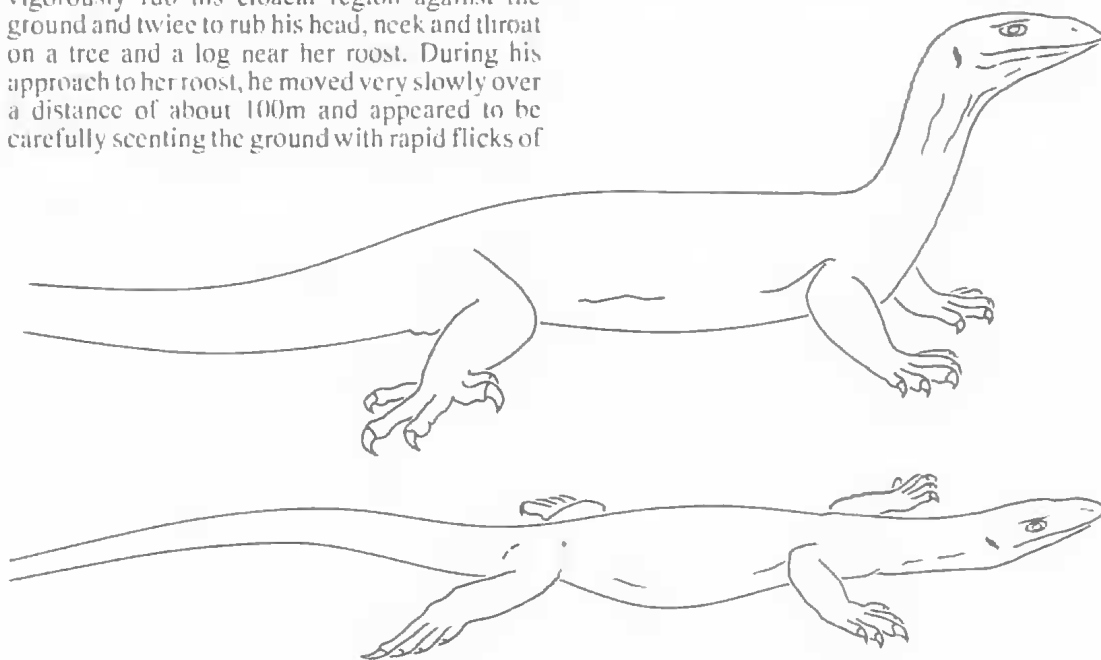


FIG. 1. Demeanour of male (top) and female (below) when they can see each other. The female remains still or crawls slowly but always with body and neck flattened to the ground. The male moves rapidly, with head raised and often makes spasmodic shuddering movements of the head as he approaches the female. His behaviour towards other males is similar.

held high and frequently jerked from side to side in a spasmodic, shuddering fashion. This head shuddering became more frequent and pronounced when closely approaching a female. The unmarked male which spent at least an hour locating female 32 used this head shuddering signal when he looked up from the base of her tree and first saw her looking down at him from a height of about 5m. She immediately descended and they mated several times during the next hour. On another occasion when an unmarked female in a mating group was alarmed by my approach and climbed a tree, male 11 who was trying to mate with her climbed up after her and repeatedly gave the head shuddering signal. She ignored him and remained in the tree for the next 2h while I continued to watch the remaining animals, which appeared unconcerned by my presence. Head shuddering was also employed by males approaching each other - most vigorously by the largest of the males.

MATING

Twenty four acts of mating were observed. Female 14 and an unmarked male, with no other animals present, mated 16 times over a period of 3h. Another pair consisting of female 32 and an unmarked male mated 7 times over a period of 1h. In both these cases the unmarked males were relatively small - about 60cm snout-vent length - and certainly smaller than other males seen in the vicinity. Female 14 and the large male 11 were in a group with another female and 3 other males and, over a period of 2h, mated only once although male 11 spent much of the time circling, hissing and chasing other males.

From these observations, mating behaviour can be summarised as follows. The female lies still and flat on the ground with neck fully extended and head on the ground (Fig. 1). The male

approaches from the rear and to one side with body raised clear of the ground. The head is raised with the snout markedly tilted down towards the female and darts rapidly from side to side as he flicks his tongue over her back and neck (Fig 2). Sometimes the male's head movements appear to be an involuntary spasm or shudder. He brings his head up to the right of hers, his body lying diagonally across hers and his vent adjacent to the left side of her tail. He then reaches over the base of her tail with his right hind foot and scrabbles at the right side of her tail with his claws apparently to stimulate her to raise the base of her tail. She recurves her back, lifts her hindquarters off the ground and raises her tail in a high arch. With his right hind foot still over the top of her tail and holding it firmly, he curves the base of his tail under hers to insert the right hemipenis (Fig. 3).

Events so far have taken about half a minute and the pair may lie still in this position for a further half minute or so. Both may look around; the female with neck extended horizontally and head tilted up, the male with neck vertical and head horizontal. He may open his mouth slightly and pump the gular region presumably to cool. Then he begins vigorous thrusting, powered primarily by the left hind leg. Twenty or 30 thrusts may be made over about one minute with the last one or two being slower and much less vigorous. The muscle tension in both animals then subsides, the arched tails relax and they uncouple. The time taken from the initial approach by the male to uncoupling is two to three minutes.

The next copulation may commence within two or three minutes and in most cases the male approaches from the other side and uses the other hemipenis. After several copulations the male may retire to the shade to cool for a few minutes

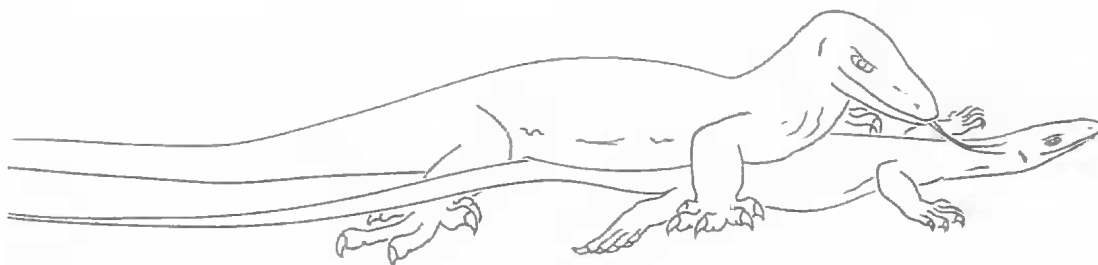


FIG. 2. Courtship. The male begins to straddle the female, rapidly flicking his tongue over her back, neck and head. He may rake the claws of one front leg down her back. She remains flattened.

before returning to mate again. The female may terminate a period of mating by climbing a tree or may prevent the male from mounting by continually crawling forwards. During the last few matings between 14 and the unmarked male there was no vigorous thrusting as the male appeared to tire. On one occasion during mating between female 32 and the unmarked male, he raked his front claws several times along her back.

DISCUSSION

A comparison of my observations with those of Moehn (1984) for captive *V. timorensis*, Auffenberg (1978, 1981) for wild *V. komodoensis* and Auffenberg (1983) for captive *V. bengalensis* reveals differences in behaviour and timing of courtship events. None of these papers report head shuddering or jerking behaviour by males in courtship although Davis et al. (1986) report such behaviour by male *V. dumerili* prior to combat. Neither Moehn nor Auffenberg emphasise distinctive demeanours for males and females early in courtship although Auffenberg (1983) reports 'do nothing' behaviour by female *V. bengalensis* which seems to encourage courtship by males and Moehn mentions that female *V. timorensis* are 'passive' during courtship. Mating of *V. timorensis* was markedly prolonged compared to *V. varius*. Whereas *V. timorensis* were coupled for up to 47 min and pelvic thrusting occurred at intervals of 5 to 22 s, *V. varius* coupled for no more than four minutes and executed 20 or 30 pelvic thrusts within about one minute. *V. bengalensis* completed courtship and intromission in a maximum of 123 s.

In both *V. komodoensis* and *V. bengalensis* Auffenberg emphasises the aggressive nature of females which he regards as a danger to males attempting to mate. He regards the pacifying and immobilising of females as an important part of courtship behaviour in these species and he interprets the mating success of large males as largely due to their ability to restrain females. I observed no aggressive behaviour by *V. varius* females towards males or other females. In general, females appeared to be cooperative until they terminated a period of mating by climbing a tree. During mating males did not restrain the forelegs of the female as Auffenberg reports for *V. bengalensis* although male *V. varius* maintained a firm grip on the female's tail with his hind leg during intromission. In this species males grow much larger than females (Carter, unpubl. obs.) and in all cases I observed the males were at least twice the mass of their partners. The initial approach by a male *V. varius* with raised body and conspicuous head movements may advertise his size and strength, as well as communicate his sex, and inhibit aggressive behaviour in females.

A prolonged period during which a pair mate frequently, as in *V. varius*, has not been reported for other species of varanids.

Several communication and courtship acts of *V. varius* coincide with the behaviour of other varanids. Tongue flicking over the female's back and neck, scratching upwards with the hind leg at the base of the female's tail, scratching the female's back with the foreleg and the position for mating are similar in *V. komodoensis*, *V. bengalensis*, *V. timorensis* and *V. varius*. Also, Auffenberg (1981) describes the importance of

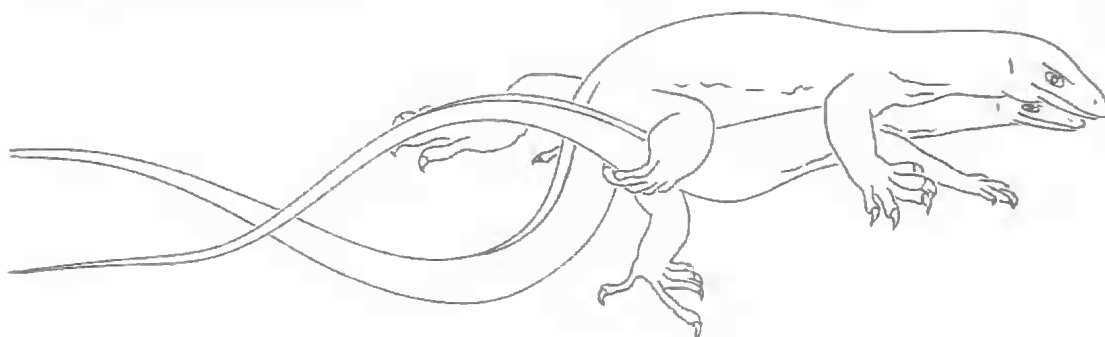


FIG. 3. Mating. The male has reached over her tail with his hind leg, scrabbling upwards on the side of her tail with his claws. She has responded by recurving her back, raising her hindquarters and arching her tail. With his hind foot gripping her tail he has then been able to curve his tail under hers and insert his right hemipenis.

scent marking in the behaviour of *V. komodoensis* and reports behaviour such as 'head scraping', 'cloaca scraping' and deposition of faeces.

That females are so readily able to mate with smaller males even though a dominant male may be in the vicinity is puzzling. The fierce fighting between males during the mating season, often resulting in large wounds (Carter, unpub. obs.), suggests that there is strong competition for mates. Yet females are left unattended by dominant males for long periods when they may mate with subordinate males. There may be mechanisms related to sperm competition or timing of fertilisation which would confer some advantage to dominant males.

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